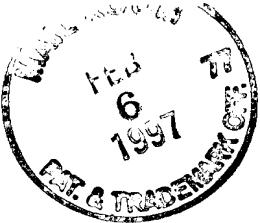SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, Koji Arai, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan have invented certain new and useful improvements in

COMMUNICATION METHOD AND APPARATUS FOR A RADIO LOCAL AREA NETWORK SYSTEM USING MACRODIVERSITY

of which the following is a specification : -

1 TITLE OF THE INVENTION

COMMUNICATION METHOD AND APPARATUS FOR A

RADIO LOCAL AREA NETWORK SYSTEM USING MACRODIVERSITY

5 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a
communication method and apparatus for a radio local
area network (LAN) system, and more particularly, to a
10 communication method and apparatus for a radio local
area network (LAN) system, in which transmission
performance may be improved by macrodiversity using a
plurality of radio base stations.

15 2. Description of the Related Art

Recently, in a radio LAN system using a
millimeter-wave band (for example, 30 GHz to 60 GHz),
a very broad band transmission (for example, more than
100-Mbps bit rate) is developing. In this case,
20 taking millimeter-wave transmission performance into
account, communication between a transmit unit and a
receive unit needs to be a line-of-sight
communication.

However, for example, in a radio LAN system
25 used in an office, a radio transmission path between
the transmit unit and the receive unit may be
interrupted by person's motion or movement of people.
In this case, a communication signal is also
interrupted and may not be transmitted. To prevent
30 the above-discussed interruption to the communication
signal, macrodiversity is proposed.

FIG. 1 shows a configuration example of a
prior-art radio LAN system using macrodiversity. In
the prior-art radio LAN system using macrodiversity,
35 inside the office, for a single terminal station
connected to at least one terminal unit, a plurality
of radio base stations (for example, base stations 1

1   to n) are provided. A signal transmitted from a wiring LAN system is transmitted to the plurality of radio base stations through a HUB (an apparatus for branching a network) in an asynchronous transfer mode

5   (ATM). Then, from the plurality of radio base stations, the signals are simultaneously transmitted to the terminal station on different frequencies (f1 to fn).

    When the terminal station receives the

10   signals transmitted from the plurality of radio base stations, the terminal station selects an optimum one (for example, a signal having a highest level) of the received signals, and demodulates a selected signal. In this way, by providing a plurality of transmission

15   paths between a transmit side and a receive side, influence due to the above-discussed interruption to the transmission signal may be prevented. In this case, it is noted that to provide the radio LAN system shown in FIG. 1, for all of the transmission paths,

20   substantially the same desired C/N (a ratio of energy of a modulated carrier signal to noise energy) ratio is required.

    However, the following problem occurs in the above-discussed prior-art radio LAN system.

25   As previously discussed, in the radio LAN system, broad band transmission having a transmission rate of more than 100 Mbps is developing. In the prior-art radio LAN system shown in FIG. 1, to realize broad band transmission or more than 100-Mbps

30   transmission rate, it is necessary for all of the transmission paths to achieve substantially the same desired C/N ratio at a transmission rate of more than 100 Mbps. In order to satisfy the above-discussed conditions, for all of the radio base stations,

35   excessive transmit power is required, and antenna gain of all the radio base stations and the terminal station needs to be further increased.

1   Further, in the prior-art radio LAN system,
a number of carriers corresponding to a number of
radio base stations is required. Therefore, a broad
transmission frequency band is required for the number
5   of radio base stations, and, thus, efficient use of
frequencies may be degraded.

SUMMARY OF THE INVENTION

         It is an object of the present invention to
10   provide a communication method and apparatus for a
radio LAN system using a macrodiversity function. In
the method and apparatus, a broad band transmission
may be provided with relatively low transmit power,
relatively low antenna gain, and a relatively narrower
15   transmission frequency band. This permits the
disadvantages described above to be eliminated.
         The object described above is achieved by a
communication method for a radio LAN system having a
communication at a first transmission rate, the method
20   comprising the steps of: (a) time-divisionally
distributing a first signal of the first transmission
rate into n-1 second signals (n = 3, 4, ...); (b)
respectively converting the n-1 second signals into n-
1 third signals of a second transmission rate less
25   than the first transmission rate; and (c) transmitting
the n-1 third signals of the second transmission rate
through radio transmission paths between n-1 radio
base stations and a terminal station connected to at
least one terminal unit.
30   The object described above is also achieved
by the method mentioned above, wherein the second
transmission rate is 1/(n-1) of the first transmission
rate.
         The object described above is also achieved
35   by a communication apparatus for a radio LAN system
which provides communication at a first transmission
rate, the apparatus comprising: a rate-conversion-and-

1 distribution circuit for time-divisionally
distributing a first signal of the first transmission
rate into n-1 second signals (n = 3, 4, ...) and
respectively converting the n-1 second signals into n-
5 1 third signals of a second transmission rate less
than the first transmission rate; and n-1 radio base
stations transmitting the n-1 third signals of the
second transmission rate to a terminal station
connected to at least one terminal unit through radio
10 transmission paths.

The object described above is also achieved
by the apparatus mentioned above, wherein the second
transmission rate is 1/(n-1) of the first transmission
rate.
15 The object described above is also achieved
by a terminal station used in a radio LAN system
having a rate-conversion-and-distribution circuit for
time-divisionally distributing a first signal of a
first transmission rate into n-1 second signals (n =
20 3, 4, ...) and respectively converting the n-1 second
signals into n-1 third signals of a second
transmission rate less than the first transmission
rate, and n-1 radio base stations transmitting the n-1
third signals of the second transmission rate to the
25 terminal station connected to at least one terminal
unit through radio transmission paths, the terminal
station comprising: a receiver receiving the third
signals of the second transmission rate transmitted
from the n-1 radio base stations; and a rate-
30 conversion-and-multiplex circuit for converting and
multiplexing received third signals of the second
transmission rate into signals of the first
transmission rate.

According to the above-discussed method for
35 the radio LAN system, apparatus for the radio LAN
system, and terminal station used in the radio LAN
system, a fast transmission rate signal is converted

1   to a lower transmission rate signal, and the lower transmission rate signal is transmitted through radio transmission paths from a plurality of radio base stations to the terminal station. Therefore, under

5   the same transmit power from the radio base stations, a ratio of a modulated signal to noise (C/N) of the lower transmission rate signal may be larger than that of the fast transmission rate signal.

          Namely, in order to obtain a desired C/N,

10   using the lower transmission rate signal, the transmit power of the radio base station may be reduced, and also, antenna gain of the radio base station and the terminal station may be reduced. As a result, power consumption of the radio LAN system may be reduced.

15   Further, a relatively simplified antenna is applicable for the radio LAN system.

          The object described above is also achieved by the method mentioned above, wherein: the radio LAN system further comprises at least one redundant radio

20   base station n; and the method further comprises the steps of: (d) transmitting a fourth signal through a radio transmission path between the terminal station and the at least one redundant radio base station n, data of the fourth signal having a given relationship

25   with data in signals transmitted between at least k (k≤(n-1)) radio base stations of the n-1 radio base stations and the terminal station; and (e) compensating, when at least one transmission path between the at least k radio base stations and the

30   terminal station is interrupted, data of the signal to be transmitted through an interrupted transmission path based on the data of the fourth signal transmitted between the at least one redundant radio base station n and the terminal station.

35   The object described above is also achieved by the method mentioned above, wherein the given relationship in the step (d) is that the data of the

1   fourth signal transmitted between the at least one
     redundant radio base station n and the terminal
     station is a summation of data of the signals
     transmitted between the at least k radio base stations
5   and the terminal station for each given time slot.

          The object described above is also achieved
     by the method mentioned above, wherein: the radio LAN
     system further comprises at least one redundant radio
     base station n; and the method further comprises the
10   steps of: (f) monitoring interruption of transmission
     paths between the n-1 radio base stations and the
     terminal station; and (g) compensating, when one of
     the transmission paths is interrupted, data of an
     interrupted transmission path by transmitting the data
15   of the interrupted transmission path between the at
     least one redundant radio base station n and the
     terminal station.

          The object described above is also achieved
     by the apparatus mentioned above, further comprising:
20   at least one summation circuit for generating a fourth
     signal by summing data of at least k (k≤(n-1)) signals
     of the n-1 third signals of the second transmission
     rate for every timeslot; and at least one redundant
     radio base station n transmitting the fourth signal
25   generated in the at least one summation circuit to the
     terminal station.

          The object described above is also achieved
     by the apparatus mentioned above, further comprising:
     at least one redundant radio base station n
30   transmitting a signal to the terminal station; a line
     monitoring circuit for monitoring interruption of
     transmission paths between the n-1 radio base stations
     and the terminal station; and a switching circuit,
     when at least one of the transmission paths is
35   interrupted, for forwarding a signal to be transmitted
     through an interrupted transmission path to the at
     least one redundant radio base station n.

1   The object described above is also achieved
by a terminal station used in a radio LAN system
having a rate-conversion-and-distribution circuit for
time-divisionally distributing a first signal of a
5   first transmission rate into n-1 second signals (n =
3, 4, ...) and respectively converting the n-1 second
signals into n-1 third signals of a second
transmission rate less than the first transmission
rate, n-1 radio base stations transmitting the n-1
10   third signals of the second transmission rate to the
terminal station connected to at least one terminal
unit through radio transmission paths, at least one
first summation circuit for generating a fourth signal
by summing data of at least k (k≤(n-1)) signals of the
15   n-1 third signals of the second transmission rate for
every timeslot, and at least one redundant radio base
station n transmitting the fourth signal generated in
the at least one first summation circuit to the
terminal station, the terminal station comprising: a
20   receiver receiving the third signals of the second
transmission rate transmitted from the n-1 radio base
stations; a rate-conversion-and-multiplex circuit for
converting and multiplexing received third signals of
the second transmission rate into signals of the first
25   transmission rate; a line monitoring circuit for
monitoring interruption of transmission paths between
the n-1 radio base stations and the terminal station;
at least one second summation circuit, when at least
one of the transmission paths is interrupted, for
30   generating a fifth signal by summing every timeslot
data of at least k signals of signals transmitted from
the n-1 radio base stations except for a signal to be
transmitted through an interrupted transmission path;
at least one subtraction circuit for generating
35   subtraction data between data of the signal
transmitted from the redundant radio base station n
and data of the fifth signal generated in the second

1   summation circuit; and a switching circuit for
     providing the subtraction data generated in the
     subtraction circuit to the rate-conversion-and-
     multiplex circuit instead of providing data of an
5   interrupted signal detected in the monitoring circuit;
     wherein even if at least one of signals transmitted
     from the n-1 radio base stations is interrupted, data
     of the interrupted signal is compensated.
              The object described above is also achieved
10   by a terminal station used in a radio LAN system
     having a rate-conversion-and-distribution circuit for
     time-divisionally distributing a first signal of a
     first transmission rate into n-1 second signals (n =
     3, 4, ...) and respectively converting the n-1 second
15   signals into n-1 third signals of a second
     transmission rate less than the first transmission
     rate, n-1 radio base stations transmitting the n-1
     third signals of the second transmission rate to the
     terminal station connected to at least one terminal
20   unit through radio transmission paths, at least one
     redundant radio base station n transmitting a signal
     to the terminal station, a first line monitoring
     circuit for monitoring interruption of transmission
     paths between the n-1 radio base stations and the
25   terminal station and a first switching circuit when at
     least one of the transmission paths is interrupted,
     for forwarding a signal to be transmitted through an
     interrupted transmission path to the at least one
     redundant radio base station n; the terminal station
30   comprising: a receiver receiving the third signals of
     the second transmission rate transmitted from the n-1
     radio base stations; a rate-conversion-and-multiplex
     circuit for converting and multiplexing received third
     signals of the second transmission rate into signals
35   of the first transmission rate; a second line
     monitoring circuit for monitoring interruption of
     transmission paths between the n-1 radio base stations

1   and the terminal station; and a second switching
       circuit, when at least one of the transmission paths
       is interrupted, for providing the signal transmitted
       from the redundant radio base station to the rate-
5   conversion-and-multiplex circuit instead of providing
       a signal to be transmitted through an interrupted
       transmission path; wherein even if at least one of
       signals transmitted from the n-1 radio base stations
       is interrupted, data of the interrupted signal is
10   compensated.

                 According to the above-discussed method for
       the radio LAN system, the apparatus for the radio LAN
       system, and the terminal station used in the radio LAN
       system, in order to establish a fast data
15   communication, the lower transmission rate data is
       transmitted through a plurality of radio transmission
       paths. Further, an additional redundant radio
       transmission path is provided, and the data in the
       interrupted transmission path is compensated.
20   Therefore, the transmit power and the
       antenna gain in the radio LAN system may be reduced,
       and also, a compensating function of the data of the
       interrupted transmission path may be obtained. As a
       result, a higher-rate-(broad band) data-transmission
25   radio LAN system may be realized.
                 Further, since a required frequency band for
       transmission between the respective radio base
       stations and the terminal station may be reduced, even
       if taking a frequency band required for the redundant
30   radio base station into account, usage frequency band
       for the radio LAN system may be significantly reduced.
                 Particularly, in the above-discussed
       specified system, the signal to be transmitted through
       the interrupted transmission path may be flexibly
35   allocated to the redundant radio transmission path.
       Therefore, even when the transmission paths, a number
       thereof being the same as a number of the redundant

1 radio transmission paths, are interrupted, signal data
of the interrupted transmission paths may be
efficiently compensated.

Other objects and further features of the
5 present invention will be apparent from the following
detailed description when read in conjunction with the
accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS
10 FIG. 1 shows a configuration example of a
prior-art radio local area network (LAN) system using a
macrodiversity;

FIG. 2 shows a block diagram of a first
embodiment of a radio LAN system according to the
15 present invention;

FIG. 3 shows illustrations for explaining an
operation of a data-rate conversion part shown in FIG.
2. A signal A indicates an input signal, signals B
indicate temporally divided signals, and signals C
20 indicate output signals for respective radio base
stations after rate conversion;

FIG. 4 shows an illustration for explaining
a relationship between signal data for radio base
stations 1 to 3 and signal data for a redundant radio
25 base station n, the signal data for the radio base
stations 1 to n being provided in the signals C shown
in FIG. 3;

FIG. 5 shows a configuration example of the
data-rate conversion part and the radio base stations
30 shown in FIG. 2;

FIG. 6 shows a configuration example of a
terminal station shown in FIG. 2;

FIG. 7 shows a block diagram of a second
embodiment of the radio LAN system according to the
35 present invention;

FIG. 8 shows a configuration example of a
data-rate conversion part and radio base stations

1   shown in FIG. 7;

FIG. 9 shows a configuration example of a
terminal station shown in FIG. 7;

FIG. 10 shows a block diagram of a third
5   embodiment of the radio LAN system according to the
present invention;

FIG. 11 shows a configuration example of a
data-rate conversion part and radio base stations
shown in FIG. 10;

10   FIG. 12 shows a block diagram of a fourth
embodiment of the radio LAN system according to the
present invention; and

FIG. 13 shows a configuration example of a
data-rate conversion part and radio base stations
15   shown in FIG. 12.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First, a description will be given of a
first embodiment of a radio LAN system according to
20   the present invention, by referring to FIG. 2 to FIG.
6.   FIG. 2 shows a block diagram of the first
embodiment of the radio LAN system according to the
present invention.   FIG. 3 shows illustrations for
explaining an operation of a data-rate conversion part
25   shown in FIG. 2.   A signal A indicates an input
signal, signals B indicate temporally divided signals,
and signals C indicate output signals for respective
radio base stations after rate conversion.

FIG. 4 shows an illustration for explaining
30   a relationship between signal data for radio base
stations 1 to 3 and signal data for a redundant radio
base station n, the signal data for the radio base
stations 1 to n being provided in the signals C shown
in FIG. 3.   FIG. 5 shows a configuration example of
35   the data-rate conversion part and the radio base
stations shown in FIG. 2.   FIG. 6 shows a
configuration example of a terminal station shown in

1   FIG. 2.

In the radio LAN system according to the
present invention shown in FIG. 2, inside an office,
for a single terminal station 10 connected to at least
5   one terminal unit, a plurality of radio base stations
(in this case, a radio base station 1, a radio base
station 2, a radio base station k (=3), and a radio
base station n are provided.

In the first embodiment shown in FIG. 2, the
10   radio base station n is used for the redundant radio
base station (discussed in detail later). A signal
transmitted from an external wiring LAN system is
provided to a data-rate conversion part 20 through a
HUB in an ATM. This input signal is represented by
15   the signal A shown in FIG. 3. The input signal
contains a signal for a terminal unit A, a signal for
a terminal unit B, and a signal for a terminal unit C
in addition to a discrimination signal.

Different cases can exist in a connecting
20   relation between the terminal station 10 and the
terminal units A to C. For example, in one case, for
each terminal station, the terminal unit is provided.
In another case, a plurality of terminal units belong
to a single terminal station. In either cases, by an
25   address provided for each data, each data may be
properly transmitted to an addressed terminal unit.

In the data-rate conversion part 20, as
shown in the signals B in FIG. 3, the discrimination
signal and the respective terminal-unit signals
30   contained in the input signal A are time-divisionally
divided into three signals for the radio base stations
1 to k (in the embodiment, k = 3) for each of the
timeslots.

Further, as shown in the upper three signals
35   of the signals C in FIG. 3, respective rates of the
three divided signals are converted to three lower-
rate signals. In this embodiment, the converted rate

1   is one-third of the input-signal data rate. Namely,
in general, the input-signal data rate is converted to
one divided by the number of radio base stations n-1
(in this case, $k=n-1$).

5   Also, as shown in the bottom signal of the
signals C in FIG. 3, for the redundant radio base
station n, specified data which has a given
relationship with the data of the divided three
signals is generated. For example, as shown in FIG.

10   4, the signal data for the redundant radio base
station n may be set as a summation of the three
signal data for the radio base stations 1 to k.

       The above-discussed operation may be carried
out by the configuration example of the data-rate

15   conversion part 20 shown in FIG. 5. In a rate-
conversion-and-distribution circuit 22 of the data-
rate conversion part 20 shown in FIG. 5, the input
signal shown in the signal A of FIG. 3 is converted to
the upper three signal data of the signals C in FIG.

20   3. Subsequently, in a summation circuit 24, the three
signal data for the radio base stations 1 to k are
summed with each other to produce the signal data for
the redundant radio base station n. In FIG. 5, for
example, when a 156-Mbps transmission signal is

25   provided from the wiring LAN system through the ATM-
HUB, three 52-Mbps (= 156 Mbps / 3) transmission
signals are transmitted to the radio base stations 1
to 3 and the redundant radio base station n.

       Next, the four lower-rate-converted signals

30   shown in the signals C of FIG. 3 are respectively
transmitted to the terminal station 10. The terminal
station 10 receives the above-discussed four signals
through antennas and receivers corresponding to the
four radio base stations.

35   As shown in FIG. 6, the terminal station 10
has a rate-conversion-and-multiplex circuit 11 which
converts the transmission rate (in this case, 52 Mbps)

1 of the three signals transmitted from the radio base
stations 1 to 3 and multiplexes them to reproduce an
original fast rate signal (shown in the signal A of
FIG. 3, 156 Mbps). The reproduced 156-Mbps signal
5 contains the signal for the terminal unit A, the
signal for the terminal unit B, and the signal for the
terminal unit C. If only the terminal unit A is
connected to the terminal station 10, only the signal
for the terminal unit A is provided to the terminal
10 unit A from the reproduced 156-Mbps signal.

As discussed above, in the radio LAN system
according to the present invention, the fast-rate
transmission signal transmitted from the wiring LAN
system is converted to the lower-rate transmission
15 signal, and is transmitted from the plurality of radio
base stations to the terminal station 10. Therefore,
under the same transmit power, a ratio of the
modulated signal to noise (C/N ratio) in the lower-
rate transmission signal becomes large as compared to
20 that in the fast-rate transmission signal. Namely, in
order to obtain the desired C/N ratio, in a case of
the lower-rate transmission signal, the transmit power
of the radio base station may be reduced, and the
antenna gains of the radio base stations and the
25 terminal station may also be reduced. Therefore,
power consumption of the radio LAN system may be
reduced, and a relatively simplified antenna is usable
for the radio LAN system.

Next, a description will be given of an
30 operation of the radio LAN system according to the
present invention when one of the three transmission
paths between the radio base stations 1 to 3 and the
terminal station 10 is interrupted. In the following,
for example, as shown in FIG. 2, a case where the
35 transmission path between the radio base station 3 and
the terminal station 10 is interrupted will be shown.

In the terminal station 10 shown in FIG. 6,

1   the three signals transmitted from the radio base
     stations 1 to 3 are respectively monitored by
     interruption detection circuits 12-1, 12-2, 12-3, and
     which transmission path has been interrupted may be
5   determined by an interruption detection control
     circuit 14. The interruption detection circuits 12-1,
     12-2, 12-3 may be easily constructed with, for
     example, an RF level detector, etc.
         Further, in FIG. 6, in the same way as the
10   summation circuit 24 in the data-rate conversion part
     20 shown in FIG. 5, the three signals from the radio
     base stations 1 to 3 are summed for each given
     timeslot in a summation circuit 13. In this case,
     when signal data transmitted from the interrupted
15   transmission path is substantially random data due to
     noise, the interruption detection control circuit 14
     controls the signal data transmitted from the
     interrupted transmission path not to be added to the
     summation or to be all zero.
20   Therefore, in a subtraction circuit 15, when
     summed data from the summation circuit 13 is
     subtracted from the signal data transmitted from the
     redundant radio base station n, the subtraction
     circuit 15 may produce correct original signal data on
25   the interrupted transmission path. Further, the
     interruption detection control circuit 14 controls a
     switching circuit 16 to insert the correct original
     signal data from the subtraction circuit 15 into the
     interrupted transmission path.
30   The above-discussed operation may be
     commonly represented by the following equation.

         data k = data n - {data 1 + ... data (k-1) +
                 data (k+1) + ... data (n-1)},

35

         where data i indicates data transmitted from a
     radio base station i to the terminal station 10.

1   By the above-discussed operation, the signal
data lost due to interruption of the transmission path
may be compensated. In the prior-art radio LAN system
using macrodiversity, fast-rate data is transmitted to
5   the terminal station through a plurality of radio
transmission paths, the signal data lost due to
interruption of the transmission path is intended to
be compensated by signal data transmitted through
another transmission path.

10   On the contrary, in the radio LAN system
according to the present invention, in order to carry
out a data communication at the same fast-rate
transmission, the lower-rate data is transmitted to
the terminal station through a plurality of
15   transmission paths, and also, an additional redundant
transmission path is provided. As a result, the lost
data in the interrupted transmission path may be
positively compensated.

          Therefore, as discussed previously, the
20   transmit power and the antenna gain may be reduced,
and data compensation function in the interrupted
transmission path may be positively obtained. As a
result, the radio LAN system with higher-rate (broad
band) data transmission may be realized.

25   In the above-discussed radio LAN system
according to the present invention, the given
relationship described in the data-rate conversion
part 20 shown in FIG. 2 is not limited to a summation
operation. Namely, when the transmission path is
30   interrupted, lost data in the interrupted transmission
path may be determined from the other signal data by
any operation, the operation is applicable for the
data-rate conversion part 20.

          Next, a description will be given of a
35   second embodiment of the radio LAN system according to
the present invention, by referring to FIG. 7 to FIG.
9. FIG. 7 shows a block diagram of the second

1   embodiment of the radio LAN system according to the
     present invention. FIG. 8 shows a configuration
     example of a data-rate conversion part and radio base
     stations shown in FIG. 7. FIG. 9 shows a
5   configuration example of a terminal station shown in
     FIG. 7.

          The second embodiment of the radio LAN
     system shown in FIG. 7 has substantially the same
     operation as that of the first embodiment of the radio
10   LAN system shown in FIG. 2. In the radio LAN system
     shown in FIG. 7, in addition to a plurality of
     conventional radio base stations 1 to n-1 (in an
     example of FIG. 7, to simplify the description, only
     the radio base stations 1, 2 are shown), a plurality
15   of redundant radio base stations (radio base stations
     n, n+1, in FIG. 7) are provided.

          Namely, in the second embodiment shown in
     FIG. 7, in the same way as the data-rate conversion
     part 20 shown in FIG. 2, in a data-rate conversion
20   part 40, the signal (for example, 156 Mbps)
     transmitted from the wiring LAN system through the
     ATM-HUB is distributed into (n-1) signals
     corresponding to the radio base stations 1 to n-1.
     Further, the distributed signals are converted to
25   lower-rate signals (for example, 156/(n-1) Mbps). The
     above-discussed operation is carried out in a rate-
     conversion-and-distribution circuit 42 shown in FIG.
     8.

          Further, in the data-rate conversion part 40
30   shown in FIG. 8, the signals for the (n-1)
     conventional radio base stations are distributed into
     two groups of signals (for example, odd-number radio
     base stations and even-number radio base stations).
     In summation circuits 44-1, 44-2, the two groups of
35   signals are respectively summed for each given
     timeslot to generate two signals for the redundant
     radio base station n and the redundant radio base

1   station n+1.

The rate-converted signals produced from the
data-rate conversion part 40 are respectively
transmitted to the terminal station 30 on the lower
5   frequency band through the radio base stations 1 to
n+1.

In the terminal station 30 shown in FIG. 9,
signals received from the radio base stations 1 to n-1
are provided to a rate-conversion-and-multiplex
10   circuit 31. The rate-conversion-and-multiplex circuit
31 converts the received signals into original-fast-
rate (156Mbps) signals, and multiplexes the received
signals to reproduce an original signal transmitted
from the wiring LAN system.
15   In the same way as the terminal station 10
shown in FIG. 6, the terminal station 30 has
interruption detection circuits 32-1 to 32-(n-1) on
transmission paths for the radio base stations 1 to n-
1 and an interruption detection control circuit 34
20   connected to the interruption detection circuits 32-1
to 32-(n-1). The interruption detection control
circuit 34 may detect which transmission path has been
interrupted.

Further, in FIG. 9, in the same way as the
25   data-rate conversion part 40, signals transmitted from
the radio base stations 1 to n-1 are distributed into
two groups of signals (in this case, signals from the
odd-number radio base stations, and signals from the
even-number radio base stations). In summation
30   circuits 33-1, 33-2, the two groups of signals are
respectively summed for each given timeslot.

At this time, when a certain transmission
path is interrupted, since the signal data transmitted
from the interrupted transmission path is
35   substantially random data due to noise, the
interruption detection control circuit 34 controls the
signal data transmitted from the interrupted

1   transmission path not to be added to the summation or
to be all zero.

Further, in subtraction circuits 35-1, 35-2,
when summed data from the summation circuits 33-1, 33-
5   2 is respectively subtracted from the signal data
transmitted from the redundant radio base stations n
and n+1, one of the subtraction circuits 35-1, 35-2
may produce correct original signal data of the
interrupted transmission path. Further, the
10   interruption detection control circuit 34 controls a
switching circuit 34 to insert the correct original
signal data from one of the subtraction circuits 35-1,
35-2 into the interrupted transmission path.

Namely when the transmission path for the
15   odd-number radio base station is interrupted, the
correct signal data is inserted by the subtraction
circuit 35-1, and when the transmission path for the
even-number radio base station is interrupted, the
correct signal data is inserted by the subtraction
20   circuit 35-2.

According to the above-discussed radio LAN
system, in the same way as the radio LAN system shown
in FIG. 2, an advantage by the lower-rate radio
transmission is provided. Further, even when two
25   transmission paths (in the different groups) are
simultaneously interrupted, the signal data of the
interrupted transmission paths may be positively
compensated.

In the radio LAN system shown in FIG. 7, the
30   transmission paths between the radio base stations and
the terminal station 30 are distributed into the two
groups of signals, and the two redundant radio base
stations are provided. However, by providing an
additional number of groups of transmission paths and
35   an additional number of redundant radio base stations,
compensating performance for the interrupted data may
be improved.

1   Next, a description will be given of a third
embodiment of the radio LAN system according to the
present invention, by referring to FIG. 10 and FIG.
11. FIG. 10 shows a block diagram of the third
5   embodiment of the radio LAN system according to the
present invention. FIG. 11 shows a configuration
example of a data-rate conversion part and radio base
stations shown in FIG. 10. A terminal station 50
shown in FIG. 10 has substantially the same
10   configuration as that of the data-rate conversion part
and the radio base stations shown in FIG. 11.

        In the radio LAN system according to the
present invention shown in FIG. 10, inside the office,
for the single terminal station 50 connected to at
15   least one terminal unit, a plurality of radio base
stations (in this case, radio base stations 1 to n)
are provided. In the third embodiment shown in FIG.
10, the radio base station n is used for the redundant
radio base station. Further, between the respective
20   radio base stations and the terminal station 50, two-
way communications are established. Therefore, as
shown in FIG. 11, in each radio base station
(including a data-rate conversion part 60) and the
terminal station 50, a transmitter, the rate-
25   conversion-and-distribution circuit, and the rate-
conversion-and-multiplex circuit are respectively
provided.

        Further, because of the two-way
communication, by monitoring an up-link transmission
30   path from the terminal station 50 to the radio base
station, the radio base station also may monitor
whether the transmission path is interrupted (referred
to as an interruption state). Therefore, as shown in
FIG. 10 and FIG. 11, in the data-rate conversion part
35   60, an up-link monitoring mechanism comprising
interruption detection circuits 66-1 to 66-(n-1) and
an interruption detection control circuit 67 is

1   provided.

In the following, a description will be
given of an operation of the radio LAN system shown in
FIG. 10.

5   The signal transmitted from the external
wiring LAN system is provided to the data-rate
conversion part 60 through the ATM-HUB. In the same
way as the first embodiment of the radio LAN system
shown in FIG. 2, the input signal is distributed into

10   a plurality of signals, each having a 1/(n-1) of the
input-signal's transmission rate. Distributed signals
are transmitted of the terminal station 50 through the
radio base stations 1 to n-1.

In this case, to the signal for the

15   redundant radio base station n, one of the signals for
the radio base stations 1 to n-1 may be allocated by a
switching circuit 64.

In the terminal station 50, in the same
operation as that of the radio LAN system shown in

20   FIG. 2, received signals from the radio base stations
1 to n-1 are provided to a rate-conversion-and-
multiplex circuit 61 to be converted and multiplexed
into an original fast-rate (156 Mbps) signal. As a
result, an original signal which has been transmitted

25   from the wiring LAN system is reproduced.

In the same way, because of the two-way
communication, the lower-rate signals which are
converted and distributed in the terminal station 50
are transmitted to the respective radio base stations

30   1 to n-1, and are converted and multiplexed to the
original fast-rate signal in the rate-conversion-and-
multiplex circuit 61 of the data-rate conversion part
60 to reproduce the signal to be transmitted to the
wiring LAN system.

35   As shown in FIG. 10, when the transmission
paths between the radio base station k and the
terminal station 50 is interrupted, the interrupted

1   transmission path is detected by the up-link
monitoring mechanism in the data-rate conversion part
60. Subsequently, by the switching circuit 64, the
signal data in the interrupted transmission path (data
5   from the radio base station k) is transmitted to the
redundant radio base station n, and is transmitted to
the terminal station 50.

In the terminal station 50, a down-link
monitoring mechanism having the same configuration as
10   that of the up-link monitoring mechanism is provided.
Therefore, the terminal station 50 also detects the
interrupted transmission path. Accordingly, by a
switching circuit (corresponding to the switching
circuit 63 in the data-rate conversion part 60), the
15   data transmitted from the radio base station n is used
instead of the data from the radio base station k.

In the above-discussed operation, by using
the down-link monitoring mechanism in the terminal
station 50, the terminal station 50 may detect the
20   interrupted transmission path. However, also by
providing information of an output result (the
interrupted transmission path) of the up-link
monitoring mechanism into the data transmitted from
the radio base station n to the terminal station 50,
25   the terminal station 50 may detect the interrupted
transmission path from that information in order to
control the switching circuit.

Next, a description will be given of a
fourth embodiment of the radio LAN system according to
30   the present invention, by referring to FIG. 12 and
FIG. 13. FIG. 12 shows a block diagram of the fourth
embodiment of the radio LAN system according to the
present invention. FIG. 13 shows a configuration
example of a data-rate conversion part and radio base
35   stations shown in FIG. 12. A terminal station 70
shown in FIG. 12 has substantially the same
configuration as that of the data-rate conversion part

1　　and the radio base stations shown in FIG. 13.

　　　　　　The fourth embodiment of the radio LAN
　　system shown in FIG. 12 has substantially the same
　　operation as that of the third embodiment of the radio
5　　LAN system shown in FIG. 10. In the radio LAN system
　　shown in FIG. 12, in addition to a plurality of
　　conventional radio base stations 1 to n-1 (in an
　　example of FIG. 12, to simplify the description, only
　　the radio base stations 1, 2 are shown), a plurality
10　　of redundant radio base stations (radio base stations
　　n, n+1) are provided.

　　　　　　In the fourth embodiment shown in FIG. 12,
　　the operations, in which the signal transmitted from
　　the wiring LAN system through the ATM-HUB is
15　　transmitted to a terminal station 70 through a data-
　　rate conversion part 80 and the radio base stations 1
　　to n-1, and an operation that the signal produced from
　　the terminal station 70 is transmitted to the wiring
　　LAN system through the radio base stations 1 to n-1
20　　and the data-rate conversion part 80, are
　　substantially the same as the operations of the third
　　embodiment of the radio LAN system shown in FIG. 10.
　　Therefore, also in the fourth embodiment of the radio
　　LAN system, between the radio base stations 1 to n-1
25　　and the terminal station 70, the signals may be
　　transmitted at the lower transmission rate.

　　　　　　Further, in the fourth embodiment shown in
　　FIG. 12, different from the third embodiment shown in
　　FIG. 10, the redundant radio base station n+1 is
30　　additionally provided. As shown in FIG. 13, the
　　redundant radio base station n+1 with the redundant
　　radio base station n is connected to a switching
　　circuit 84. In the switching circuit 84, by an up-
　　link monitoring mechanism constructed with
35　　interruption detection circuits 86-1 to 86-(n-1) and
　　an interruption detection control circuit 87, data to
　　be transmitted to the radio base station on an

1   interrupted transmission path is controlled to be transmitted to the redundant radio base station n or the redundant radio base station n+1.

In the same way as a down-link transmission 5   path, the redundant radio base station n+1 with the redundant radio base station n is connected to a switching circuit 83. In the switching circuit 83, by the down-link monitoring mechanism, instead of data transmitted from the radio base station through the 10   interrupted transmission path, data transmitted from the redundant radio base station n or the redundant radio base station n+1 is selected and is provided to a rate-conversion-and-multiplex circuit 81.

In the above-discussed operation, when one 15   of the transmission paths between the radio base stations 1 to n-1 and the terminal station 70 is interrupted, the redundant radio base station n is used. Further, when two of the transmission paths are simultaneously interrupted, the redundant radio base 20   station n and the redundant radio base station n+1 are used.

As discussed above, in the fourth embodiment of the radio LAN system, in the same way as the radio LAN system shown in FIG. 10, advantages based on the 25   lower-rate radio transmission may be obtained. Further, even when a plurality of transmission paths are simultaneously interrupted, the signal data of the interrupted transmission paths may be positively compensated.

30   In the fourth embodiment of the radio LAN system shown in FIG. 12, the two redundant radio base stations are provided. However, by providing an additional number of redundant radio base stations, data of an additional number of interrupted 35   transmission paths may be compensated while obtaining the advantages based on the lower-rate radio transmission.

1   Further, the present invention is not limited to these embodiments, but other variations and modifications may be made without departing from the scope of the present invention.

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